**5037**

**COMPARATIVE STUDY OF NEAR- AND FAR-SIDE LUNAR SOILS: TOWARD THE UNDERSTANDING EARLY EVOLUTION OF THE EARTH AND THE MOON**

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Because of the almost total lack of geological record on the Earth for the time before 4 Ga, the Earth history during this period is still enigmatic. We propose that a comparative study of far- and near-side lunar soil would shed new light on this dark age of the Earth history as well as on the Earth-Moon system dynamic evolution.

Due to a strong dynamic coupling between the Earth and the Moon, theories have concluded that the Earth has been facing only to the near-side of the Moon since the formation of the Earth-Moon system, and that due to tidal energy dissipation, the Moon has been receding from the Earth (e.g., [1]). Therefore, we infer that there may have been substantial interaction between the Earth through the atmosphere and the near-side lunar surface, especially in ancient time, whereas the far-side has remained essentially intact to the terrestrial atmospheric influence. We suggest that the comparison of the far-side and near-side surface samples would impose crucial constraints on the evolution of the Earth and the Moon such as those listed below.

**1. When Did the Geomagnetic Field (GMF) First Appear?** Ozima et al. [2] suggested that terrestrial atmospheric components such as N and light noble gases could be transported from the Earth's atmosphere to the Moon, if the Earth was nonmagnetic. Therefore, the search for these terrestrial components in lunar soil would constrain the time for the first appearance of the geomagnetic field.

**2. Have the Day Length and Earth-Moon Distance Changed in Geological Time?** If the Moon has been receding from the Earth, the day length of the Earth should also have changed. Theoretical conclusions on these fundamental problems can be empirically constrained from the comparison of terrestrial volatile components between the near and far side lunar soils, and from the examination of vertical section of the nearside soils.

**3. When Did the Biotic Oxygen Atmosphere Form?** Ozima et al. [3] suggested that oxygen fractionated in the upper atmosphere might be responsible to the exotic oxygen observed in lunar metal by Ireland et al. [4]. The oldest record of this specific terrestrial oxygen would constrain the initiation of the biotic Earth atmosphere.

**References:** [1] Murray C. D. and Dermott S. F. 1999. *Solar system dynamics*. Cambridge: Cambridge U. Press. [2] Ozima M. et al. 2005. *Nature* 436:655–659. [3] Ozima M. et al. 2007. Abstract #1129. 32nd LPSC. [4] Ireland T. R. et al. 2006. *Nature* 440:775–778.

**5206**

**ORIGIN OF BOUNDARY CLINOPYROXENES BETWEEN SPINEL AND MELILITE IN TYPE B1 CAIs**

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**Introduction:** Small (<5 µm) boundary clinopyroxenes (b-cpx) on spinel (sp) inclusions in melilite (mel) are ubiquitous in the type B1 CAIs. B-cpx on sp in high-Åk mel in the core of the inclusion could be explained by crystallization, either initial or during remelting. However, b-cpx on sp inclusions in low-Åk mantle mel are not readily explained in this way because mantle mel crystallized and incorporated b-cpx long before the appearance of clinopyroxene (cpx) in the crystallization sequence. To further constrain the crystallization and/or alteration processes, and to test the hypothesis that b-cpx were formed from melt inclusions, we examined the sp/mel interface of four sp in Leoville and Allende CAIs using FIB/TEM.

**Results:** FIB/TEM shows only cpx as a boundary phase between sp and mel in Allende TS-34, but Leoville 3537-2 interface regions are more complex with glass (gl), calcite, perovskite (pv), and cpx in variable amounts. In general, mel is essentially unaltered in Leoville and noticeably altered in Allende CAIs, but it is the Leoville sp/mel boundaries that show evidence for alteration, whereas those for Allende do not.

Glass, probably hydrated, is found on both Leoville sp boundaries. These are unlikely to be quenched residual gl because there is no high Åk mel associated with the cpx and the compositions are incompatible with late stage CAI melts. They may reflect a previously unrecognized pre-terrestrial alteration event localized to the sp/mel boundaries. The alteration products were later converted to gl by a (mild?) shock which preferentially heated and melted the porous, possibly hydrated, alteration phases. A jagged, presumably corrosion, texture for the glass/mel interfaces supports this interpretation.

**Discussion:** B-cpx from the core are compositionally similar to coarse-grained cpx and although they may be relict relative to the most recent melting event, they likely share a common origin with the larger grains. A unique origin for b-cpx in the mantle of type B1s is required due to the anomaly of an apparent late-stage crystal being included in an early crystallizing phase. A possible clue is that type A inclusions have sp boundary pv analogous to the sp b-cpx in type B1 inclusions, and that these sometimes have a rind of cpx, interpreted by [1] as a reaction between pv and melt. Occasional pv is found in and on type B1 sp, and since pv does not occur in the crystallization of bulk type B1s, these must be regarded as relict grains [2]. Once in contact with a melt, the relict pv dissolved indirectly and often completely, reacting with the melt to form cpx. The cpx would also be unstable during initial phases of crystallization, and the texture of the b-cpx is consistent with partial resorption.

**References:** [1] El Goresy A. et al. 2002. *Geochimica et Cosmochimica Acta* 66:1459. [2] Connolly H. C. and D. S. Burnett. 1999. *Meteoritics & Planetary Science* 32:829.